Reaction: How Best to Broaden Engineering Education?

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There are several cogent reasons for seeking greater breadth in engineering education in the United States. For one, engineering activities are increasingly intertwined with complex societal needs, public concerns, and economic development. As well, classical entry-level engineering jobs are going overseas, and the U. S. engineer must have a place in the global structure. Many believe that engineering in the U. S. should build upon innovation abilities so as to warrant the salary premium needed for U. S. engineers, but a key ingredient of innovation is the ability to understand broadly beyond mere technical competence. About 1/3 of bachelor's graduates in engineering, architecture and computer science are not working in one of those fields as few as four years later (NCES, 2001). That is a good thing because engineering concepts and skills are useful in many different walks of life, but these graduates would be more effective had they been given a breadth of education that would enable them to deal with issues beyond engineering itself. Finally, breadth of education is an avenue towards a fuller and more rewarding life in general.

The proposal by Bucciarelli and Drew for a Liberal studies in Engineering major is commendable as a focused route towards more broadly trained and aware engineers. Like any innovation, it would need to go through institutional processes of approval and adoption in order to proceed. The process and the likelihood of success will vary from one type of higher-

education institution to another. This particular proposal may be more achievable in liberal-arts colleges and technical universities than in large, general research universities. However, most of the U. S. engineering enrollment is in large research universities. Some of the factors that must be overcome for these universities to institute the Liberal Studies in Engineering concept are the following.

- The collective faculty controls the curriculum and degree structure, either directly or through the administration. The necessary changes take agreement and approval by multiple faculties.
- Engineers and humanists/social scientists would need to have a common understanding of objectives and methods for the program, and there needs to be strong and sustained buy-in from both.
- Participating faculty members from all areas must conclude that involvement in the program is not a deterrent to their own career success; the faculty reward structure must be supportive of faculty involvement in this area of teaching and scholarship.
- Graduates should be able readily to find ways of going onward in engineering education or other fields such as business, medicine or law at the same institution or elsewhere.
- There has to be a supportive home for the degree program in either a department or college of a sufficiently strong interdisciplinary degree structure.
- There is probably a need for new budget for faculty, staff, space and/or operations..

For success of the new program, all of these needs will have to be satisfied. Each has a probability substantially below 1.0. For simultaneous requirements we must multiply probabilities, resulting in an overall probability that is yet lower.

We should therefore examine ways of achieving many of the same objectives with a higher probability of success and/or a higher ratio of benefits to effort. In that regard we have the following four recommendations.

First, recognize up front that the essential confining problem is the fact that engineering in the U. S. places the professional degree in engineering at the bachelor's level. The present lack of breadth in engineering education is a manifestation of the constraints that come from squeezing everything into a nominally four-year degree. All other major professions place the professional degree at the graduate level and thereby build upon a broad, less specified undergraduate education. As has been documented by one of the authors elsewhere (King, 2011), the United Kingdom has already placed the Chartered Engineer professional degree at the graduate level, and engineering enrollment is shifting more to the Master's or second-cycle level in the U. K., Ireland, Japan, Australia and other countries as additional degrees are instituted and curricula are correspondingly reexamined as changes are made to conform to the Bologna standards in Europe and outgrowths of that process are examined elsewhere. Over time these changes are putting the U. S. is in the odd, awkward, and probably untenable position of trying to produce an engineer who warrants a salary premium with respect to the rest of the world through education that is less than that provided by the rest of the world.

Second, although the change within engineering itself would be major, it should take fewer simultaneous changes with entire universities to change to a system wherein undergraduate, pre-professional education for engineers is set by emulation of pre-medical and

pre-law requirements rather than through a specified degree program. Institution of “pre-med” requirements, i. e., certain specified courses or course alternatives taken along with any of many majors, takes only the approval of the engineering faculty and not of other faculties within the university as well. This approach is also much less confining to the student and would enrich the profession as students from varied undergraduate backgrounds come into it. The pre-med approach should also be attractive to engineering departments as a way of attracting a wider variety of excellent students into engineering.

Third, get engineering explicitly included in general education requirements for all undergraduates. The time is right for this, and the need is recognized outside of engineering in universities. What is primarily holding things back is the lack of engineering courses appropriate to the purpose of general education. Effective general-education courses need to deal more with specific cases and be tied to other aspects of society and knowledge. For some years now, Princeton has had over two-thirds of all undergraduates, with a goal of 90%, of undergraduates taking at least one engineering course (EQuad News, 2005). More than 20 mcourses are designed and given for that purpose (EQuad News, 2008).

Fourth, for institutions that do want to purse a Liberal Studies in Engineering undergraduate, pre-professional degree, take advantage of the body of experience associated with existingEngineering Science and Bachelor of Arts programs, e. g., those at Dartmouth, Harvey Mudd, Smith, Yale, and Harvard, all of which are described on the respective web sites.

References

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